

**ENGINEERING-SCIENCE, INC.**

1700 Broadway Suite 900 • Denver, Colorado 80290 • (303) 831-8100 • Fax: (303) 831-8208

September 22, 1994

Mr. Marty Faile  
AFCEE/ERT  
8001 Arnold Drive  
Brooks AFB, Texas 78235-5357

RE: AFCEE Bioventing Test Initiative Final Tables

Dear Marty:

Please find attached final tables and site figures for two sites at which 12 months of bioventing pilot testing have been completed. Specifically, final tables and site figures are attached for Beale AFB - Site 11 and Travis AFB - Fuel Storage Area G (Site 1).

Please call me or Doug Downey at (303) 831-8100 if you have any questions.

Sincerely,

ENGINEERING-SCIENCE, INC.

*Brian R. Blicker*

Brian R. Blicker  
Environmental Engineer

c.c.: Doug C. Downey, P.E.  
File

**DISTRIBUTION STATEMENT A**

Approved for Public Release  
Distribution Unlimited

FIGURE 1

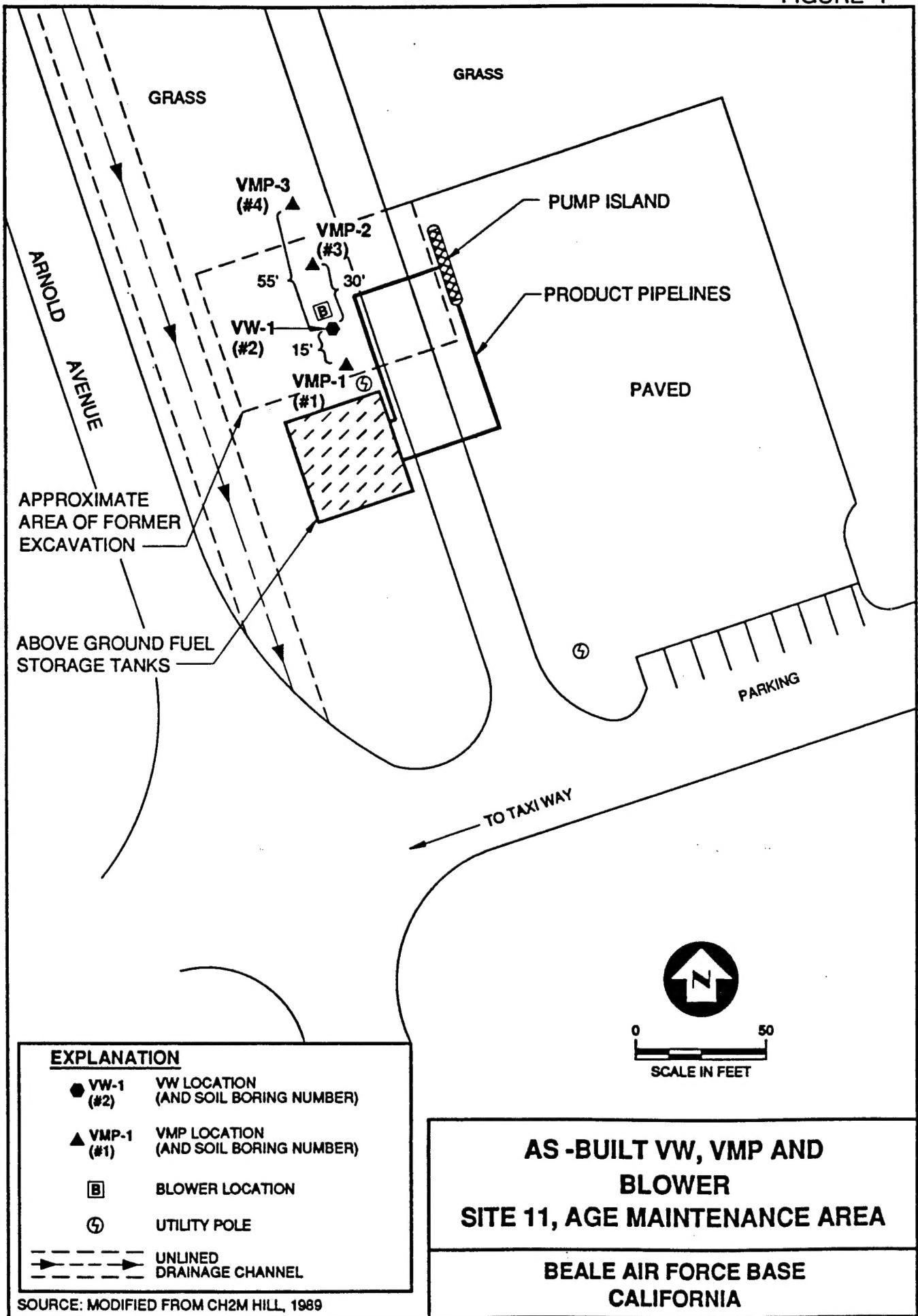


TABLE 1  
SITE 11  
RESPIRATION AND DEGRADATION RATES  
BEALE AFB, CALIFORNIA

Location-Depth	Initial - May 1993		6-Month - December 1993		Soil Temperature		$K_o$ (%O <sub>2</sub> /min)	Soil Temperature (°C)	1-Year - July 1994	
	$K_o$ (%O <sub>2</sub> /min)	Degradation Rate (mg/kg/year) <sup>a</sup>	Soil Temperature (°C)	$K_o$ (%O <sub>2</sub> /min)	Degradation Rate (mg/kg/year) <sup>b</sup>	Soil Temperature (°C)			Degradation Rate (mg/kg/year)	Soil Temperature (°C)
VMP1-24	0.0020	50	21.6	0.00065	47	23.5	0.00060	71	20.7	
VMP1-40.5	NS <sup>c</sup>	NS	22.8	NS	NS	20.4	NS	NS	20.6	
VMP2-24	0.00078	130	NS	0.00063	110	NS	0.00038	63	NS	
VMP3-30.5	0.0030	530	NS	0.00027	47	NS	0.00065	110	NS	

Notes:

<sup>a</sup> Milligrams of hydrocarbons per kilogram of soil per year.

<sup>b</sup> Assumes moisture content of soil is average of initial and final moistures.

<sup>c</sup> NS = Not Sampled

TABLE 2

SITE 11

INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS  
BEALE AFB, CALIFORNIA

Analyte (Units) <sup>a/</sup>	Sample Locations – Depth (feet below ground surface)					
	VW1		VMP1–24		VMP3–24	
Soil Gas Hydrocarbons	Initial <sup>b/</sup>	1–Year <sup>c/</sup>	Initial	1–Year	Initial	1–Year
TVH (ppmv)	51,000	7.4	72,000	3,500	55,000	4,900
Benzene (ppmv)	30	0.008	430	1.2	580	2.7
Toluene (ppmv)	74	<0.002	550	12	970	26
Ethylbenzene (ppmv)	13	0.006	40	10	59	12
Xylenes (ppmv)	310	0.12	240	140	350	390
Soil Hydrocarbons	VW1–30		VMP1–24.5		VMP2–25.5	
	Initial <sup>d/</sup>	1–Year <sup>e/</sup>	Initial	1–Year	Initial <sup>f/</sup>	1–Year
TRPH (mg/kg)	<5	85.8	<5	1,010	1,186/309	3,680
Benzene (mg/kg)	0.0035	0.0005	1.8	<0.61	<4.0/<3.9	<3.0
Toluene (mg/kg)	0.020	0.013	1.8	<0.61	150/48	<3.0
Ethylbenzene (mg/kg)	0.0043	0.0076	0.11	<0.61	68/27	13
Xylenes (mg/kg)	0.039	0.074	0.65	10	510/190	720
Moisture (%)		12.6	3.4	23.6	18.4	15.3/15.8
						15.6

<sup>a/</sup> TVH = total volatile hydrocarbons; ppmv = parts per million, volume per volume;  
TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram;

<sup>b/</sup> Initial soil gas samples collected on May 11, 1993.

<sup>c/</sup> Final soil gas samples collected on July 12, 1994.

<sup>d/</sup> Initial soil samples collected between April 19 and 21, 1993.

<sup>e/</sup> Final soil samples collected on July 20, 1994.

<sup>f/</sup> Results of primary sample/field duplicate.

FIGURE 1

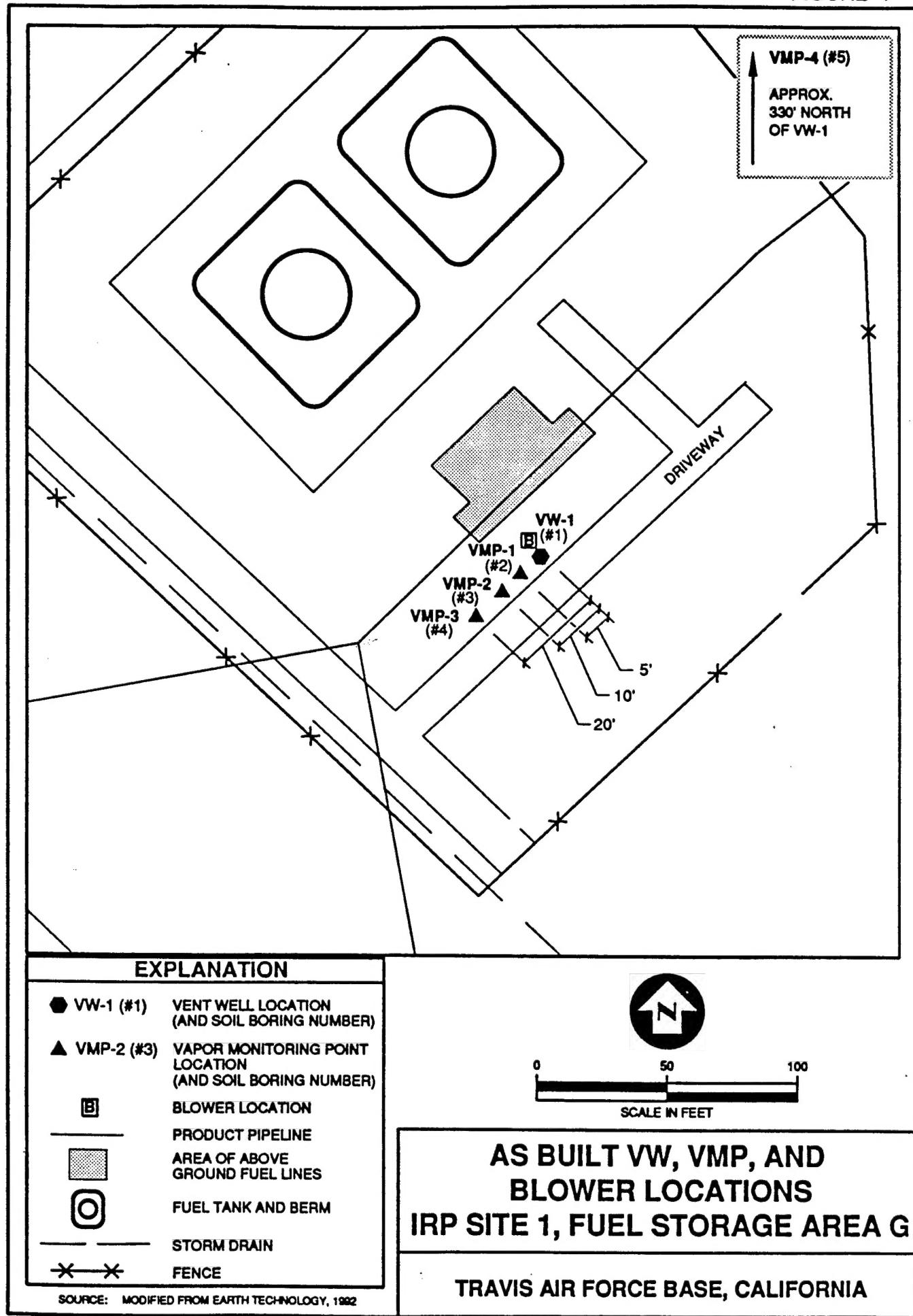


TABLE 1  
FUEL STORAGE AREA G (SITE 1)  
RESPIRATION AND DEGRADATION RATES  
TRAVIS AFB, CALIFORNIA

Location-Depth	Initial - June 1993			6-Month - December 1993			1-Year - July 1994		
	K <sub>o</sub> (% O <sub>2</sub> /min)	Degradation Rate (mg/kg/year) <sup>a/</sup>	Soil Temperature (°C)	K <sub>o</sub> (% O <sub>2</sub> /min)	Degradation Rate (mg/kg/year) <sup>b/</sup>	Soil Temperature (°C)	K <sub>o</sub> (% O <sub>2</sub> /min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
VW-1	0.047	4,500	NS <sup>c/</sup>	NS	NS	NS	0.0057	690	NS
VMP1-3.5	0.052	3,900	19.5	NS	NS	16.6	NS	NS	23.8
VMP1-6.5	0.072	4,900	19.0	0.011	1,000	20.8	0.0077	930	22.4
VMP2-5	0.067	7,100	NS <sup>c/</sup>	0.0087	880	NS	0.0080	720	NS
VMP2-9	NS	NS	NS	0.018	1,600	NS	0.025	1,800	NS
VMP3-3.5	NS	NS	NS	NS	NS	NS	0.017	1,000	NS
VMP3-6.5	0.065	3,700	NS	0.015	910	NS	0.023	1,400	NS

Notes:

<sup>a/</sup> Milligrams of hydrocarbons per kilogram of soil per year.

<sup>b/</sup> Assumes moisture content of soil is average of initial and final moistures.

<sup>c/</sup> NS = Not Sampled

TABLE 2  
FUEL STORAGE AREA G (SITE 1)  
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS  
TRAVIS AFB, CALIFORNIA

Analyte (Units) <sup>a/</sup>	Sample Locations - Depth (feet below ground surface)					
	VW1		VMP1 - 6.5		VMP3 - 6.5	
	Initial <sup>b/</sup>	1 - Year <sup>c/</sup>	Initial	1 - Year	Initial	1 - Year
<b>Soil Gas Hydrocarbons</b>						
TVH (ppmv)	110,000	340	120,000	1,400	110,000	5,200
Benzene (ppmv)	1,400	0.71	1,500	18.0	1,000	2.5
Toluene (ppmv)	670	0.86	800	16	180	17
Ethylbenzene (ppmv)	250	0.47	30	4.6	23	14
Xylenes (ppmv)	120	3.6	120	24	51	66
<b>Soil Hydrocarbons</b>						
TRPH (mg/kg)	<12	6.3	<12	6.6	12	6.9
Benzene (mg/kg)	0.022	<0.0005	0.026	<0.0005	0.38	<0.0029
Toluene (mg/kg)	0.030	<0.0005	0.027	<0.0005	2.0	<0.0029
Ethylbenzene (mg/kg)	0.012	<0.0005	0.013	<0.0005	1.5	<0.0029
Xylenes (mg/kg)	0.040	<0.0008	0.042	<0.0008	5.8	<0.0041
Moisture (%)	14.8	13.7	16.4	13.4	14.3	14.8
					NA <sup>d/</sup>	16.4

<sup>a/</sup> TVH = total volatile hydrocarbons; ppmv = parts per million, volume per volume;

TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.

<sup>b/</sup> Initial soil gas samples collected on June 7 and 8, 1993.

<sup>c/</sup> Final soil gas samples collected on July 5, 1994.

<sup>d/</sup> Initial soil samples collected on February 16, 1993.

<sup>e/</sup> Final soil samples collected on July 19, 1994.

<sup>f/</sup> NA = Not analyzed.